SECTION III. OPERATION

9.3.1 INTRODUCTION

The normal operation of the ceilometer is fully automatic and requires no operator intervention. The digital data message sent by the ceilometer to report cloud information is automatically issued as a response to sensor polling by the data collection package (DCP) at predetermined timed intervals. This data message is transferred from the ceilometer to the DCP and ultimately to the acquisition control unit (ACU) for broadcast and display.

9.3.2 CONTROLS AND INDICATORS

The ceilometer is intended for continuous operation and normally remains on at all times, with the exception of maintenance or repair requirements. The digital communications interface with the ceilometer allows the system to automatically detect and report the majority of possible malfunctions through software displays. As such, the ceilometer contains only a few controls and indicators which require setting or monitoring by the technician. These controls and indicators are illustrated on figure 9.3.1 and described in table 9.3.1.

9.3.3 TURN-ON PROCEDURES

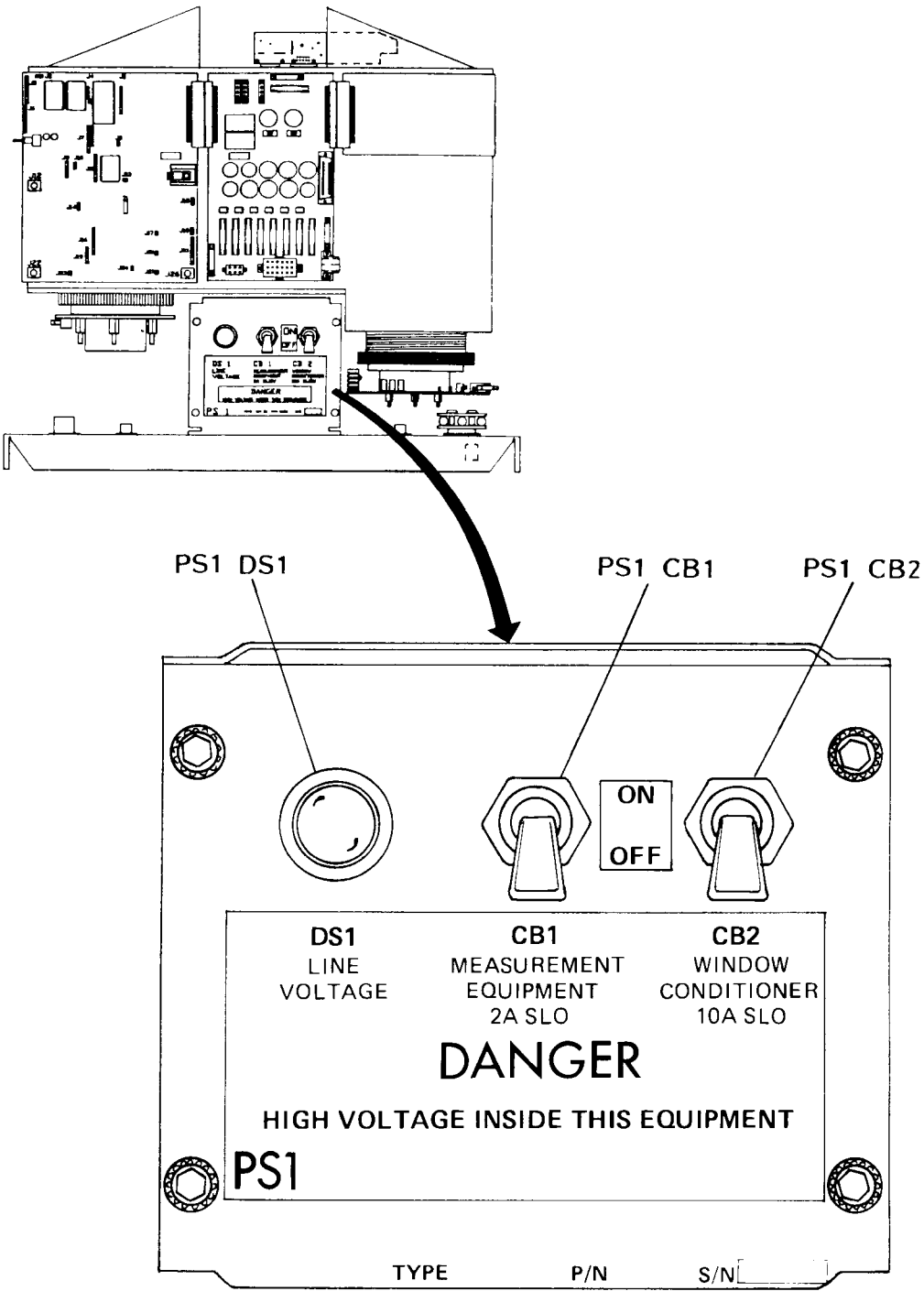
The ceilometer is designed for continuous operation and normally remains on at all times, except for maintenance or repair activities. The turn-on procedures for the ceilometer require that the cover of the equipment cabinet assembly be removed, power applied, proper operation of the ceilometer verified, power removed, the cover installed, and power applied. These procedures prohibit the dangers involved with installing the ceilometer equipment cover with the system powered on. The ceilometer turn-on procedures are provided in table 9.3.2.

9.3.4 TURNOFF PROCEDURES

The ceilometer is normally turned off only for maintenance purposes using the procedures provided in table 9.3.3. These procedures remove electrical power from the ceilometer equipment to ensure safe disassembly of the ceilometer and safe removal/replacement of field replaceable units (FRU's).

9.3.5 NORMAL OPERATION

The ceilometer normally operates in automatic mode with the polling mode on (PMOD ON), which requires no operator intervention. A digital message is sent from the ceilometer to the DCP each time that the DCP polls the ceilometer with a SEND command. The content of these messages may be viewed on the ceilometer page of the OID. A description of the OID display is provided in Chapter 1. There are three possible message outputs from the ceilometer, which are described in the following paragraphs.



HIGH VOLTAGE POWER SUPPLY PS1

Figure 9.3.1. Ceilometer Controls and Indicators (Sheet 1 of 4)

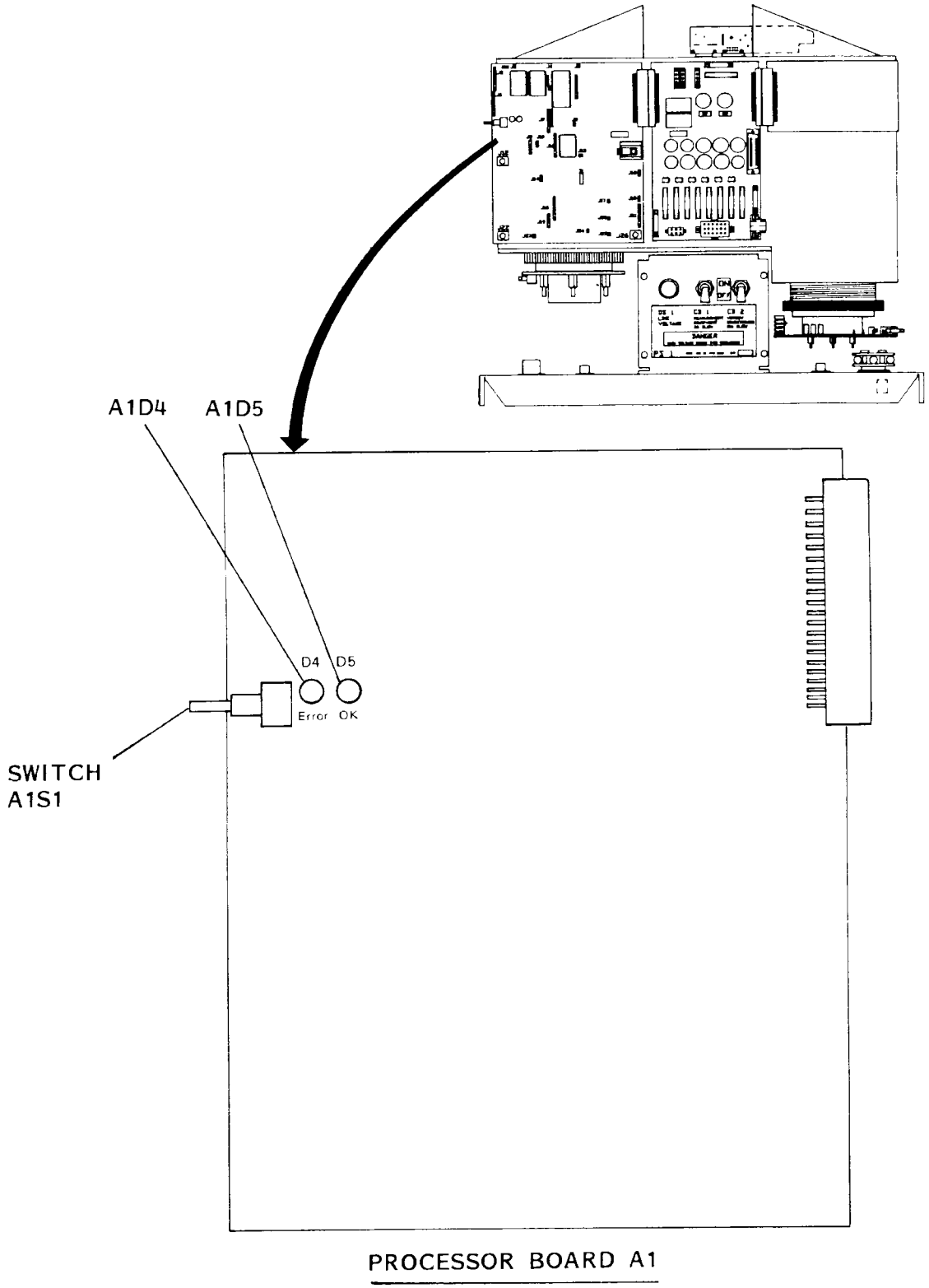


Figure 9.3.1. Ceilometer Controls and Indicators (Sheet 2)

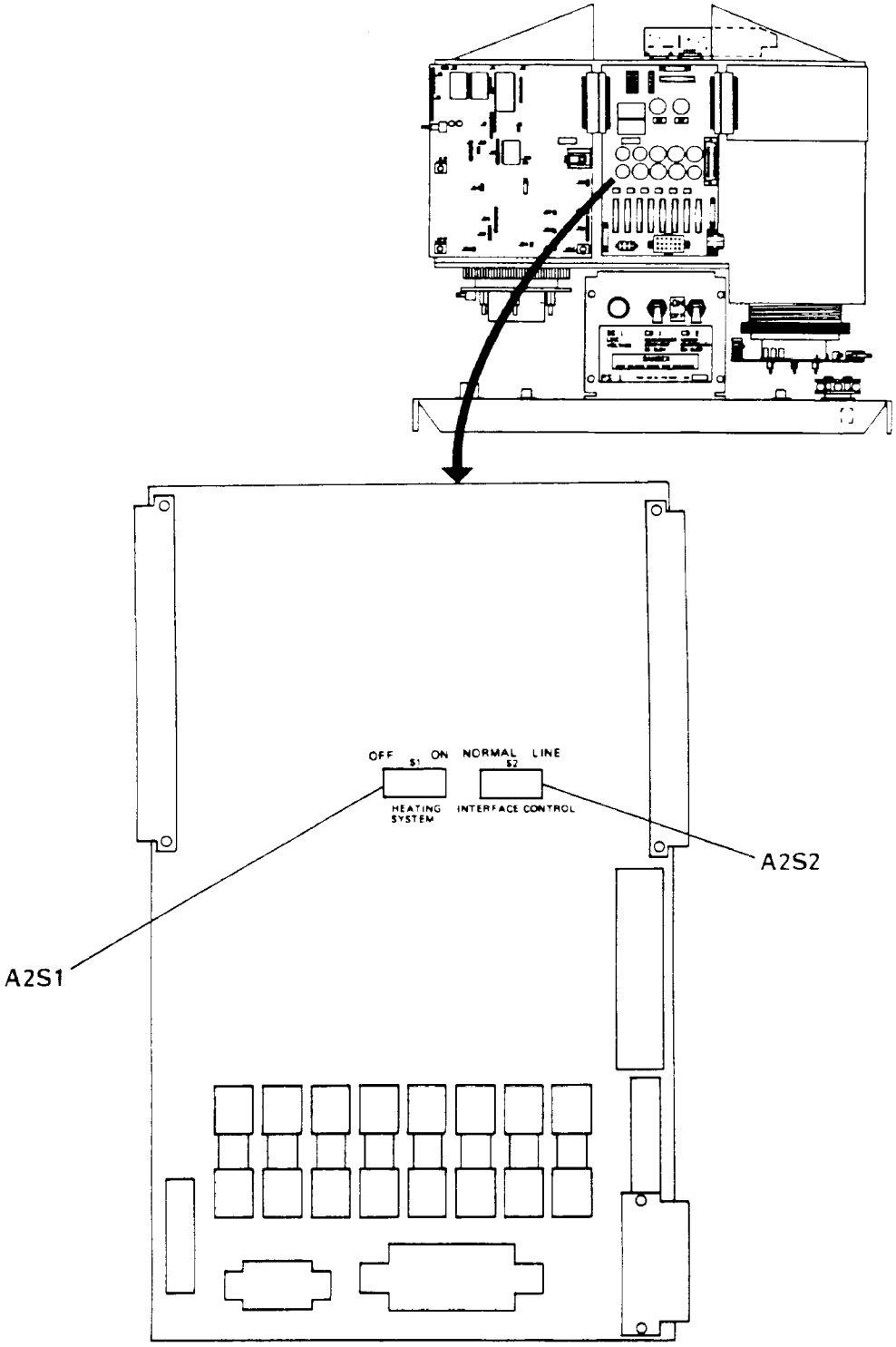
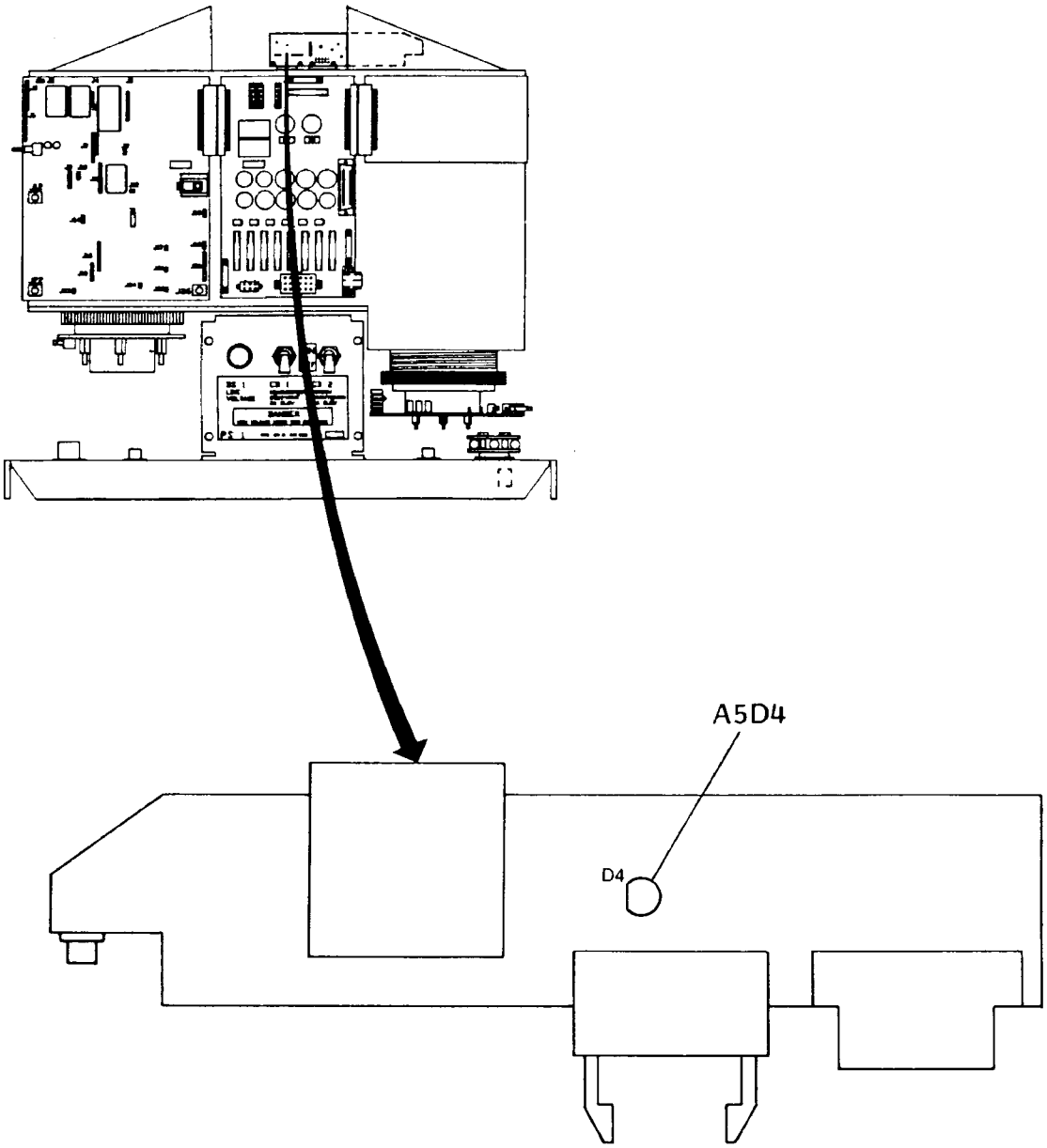


Figure 9.3.1. Ceilometer Controls and Indicators (Sheet 3)



LIGHT MONITOR BOARD A5

Figure 9.3.1. Ceilometer Controls and Indicators (Sheet 4)

Table 9.3.1. Ceilometer Controls and Indicators

Control/Indicator	Description	Normal Condition
PS1 CB1 ON/OFF	AC power circuit breaker	ON (up)
PS1 CB2 ON/OFF	Window conditioner ac power circuit breaker	ON (up)
PS1 DS1 LINE VOLTAGE	AC power indicator	On (illuminated)
A1S1	Reset/normal/(spare) switch	Normal = middle, Reset = up
A1D4	Processor alarm indicator	Normally off (extinguished)
A1D5	Processor OK indicator	Blinking once per second
A2S1 HEATING SYSTEM ON (auto)/OFF	Internal heating switch	ON (right)
A2S2 INTERFACE CONTROL NORMAL/LINE	Switch	NORMAL (left)
A5D4	Laser power indicator	Illuminates except if optional solar shutter is on

Table 9.3.2. Ceilometer Turn-On Procedures

Step	Procedure
1	Inside DCP equipment cabinet, set circuit breakers on ceilometer circuit breaker module to off (right) position.
2	At ceilometer, disconnect window conditioner cable from connector J2 on the underside of equipment cabinet assembly.
3	Loosen four knurled screws securing window conditioner to equipment cabinet assembly.
4	Lift window conditioner from equipment cabinet assembly and carefully place assembly on the ground.
5	Unfasten two latches at lower edge of ceilometer equipment cabinet assembly.
6	**CAUTION** The glass windows on the cover of the equipment cabinet assembly are specially manufactured optics. Damage to these windows, including scratches and cracks, may result in operational failure of the ceilometer. Carefully lift cover from equipment cabinet assembly and place cover on the ground.
7	Verify that all interface cables other than the window conditioner power supply cable are connected properly to the underside of equipment cabinet assembly.
8	Observe that LINE VOLTAGE indicator PS1 DS1 is extinguished.
9	Set MEASUREMENT EQUIPMENT circuit breaker PS1 CB1 and WINDOW CONDITIONER circuit breaker PS1 CB2 to OFF position.
10	Inside DCP equipment cabinet, set circuit breakers on ceilometer circuit breaker module to on (left) position.
11	At ceilometer, observe that LINE VOLTAGE indicator PS1 DS1 is illuminated, indicating the application of ac power.

Table 9.3.2. Ceilometer Turn-On Procedures -CONT

Step	Procedure
12	Set MEASUREMENT EQUIPMENT circuit breaker PS1 CB1 to ON position and observe the following: a. Processor alarm indicator A1D4 illuminates for approximately 5 seconds, indicating that a system reset is in progress. b. After processor alarm indicator A1D4 extinguishes, processor OK indicator A1D5 begins blinking approximately once each second to indicate that system software is operating.
13	Inside DCP equipment cabinet, set circuit breakers on ceilometer circuit breaker module to off (right) position.
14	At ceilometer, observe that LINE VOLTAGE indicator PS1 DS1 is extinguished.
15	Set WINDOW CONDITIONER circuit breaker PS1 CB2 to ON position.
16	**CAUTION** Glass windows on equipment cabinet assembly cover are specially manufactured optics. Damage to these windows, including scratches and cracks, may result in ceilometer operational failure. Install cover on ceilometer equipment cabinet assembly and secure two latches.
17	Install window conditioner on equipment cabinet assembly and tighten four knurled screws securing window conditioner.
18	Connect window conditioner cable to connector J2 on the underside of equipment cabinet assembly.
19	Inside DCP equipment cabinet, set circuit breakers on ceilometer circuit breaker module to on (left) position.

Table 9.3.3. Ceilometer Turnoff Procedures

Step	Procedure
1	Inside DCP equipment cabinet, set circuit breakers on ceilometer circuit breaker module to off (right) position.
2	At ceilometer, disconnect window conditioner cable from connector J2 on the underside of equipment cabinet assembly.
3	Loosen four knurled screws securing window conditioner to equipment cabinet assembly.
4	Lift window conditioner from equipment cabinet assembly and carefully place assembly on the ground.
5	Unfasten two latches at lower edge of ceilometer equipment cabinet assembly.
6	**CAUTION** Glass windows on equipment cabinet assembly cover are specially manufactured optics. Damage to these windows, including scratches and cracks, may result in ceilometer operational failure. Carefully lift cover from equipment cabinet assembly and place cover on the ground.
7	Observe that LINE VOLTAGE indicator PS1 DS1 is extinguished.
8	Set MEASUREMENT EQUIPMENT circuit breaker PS1 CB1 and WINDOW CONDITIONER circuit breaker PS1 CB2 to off (right) position.

9.3.5.1 **Startup Message**. Upon startup, the ceilometer automatically performs a series of self-tests during its initialization sequence. The results of these tests and ceilometer operating status are reported in a data message. A sample startup message is provided on figure 9.3.2.

9.3.5.2 **Digital Message No. 2**. This message contains the measured cloud return and internal monitoring data that are the normal sensor output for the ASOS configuration. The message is output every time that the DCP polls the ceilometer. The same message is output in response to the SEND 2 and MES commands in maintenance mode. The message consists of 13 lines and is shown on figure 9.3.3.

9.3.5.3 **Digital Message No. 3**. This message consists of status line 1 (identical to that described for digital message No. 2) and one single range gate data line indicating the presence or absence of backscatter in the range gate. This message is output in response to the SEND 3 command in maintenance mode. The message format is shown on figure 9.3.4.

```
VAISALA CT12K VERSION 2.46 SN:97023   DATA MEMORY OK
SEQUENCE OK
?
EEPROM OK

CT12K STATUS
00 ///// ///// ///// ///// 0000000010
POWER STATUS
P10D   8.5 P20I 21.1  M201 -20.4 P25V 27.3
M20A -20.6 P20A 19.3  P12M  12.9 P10X 9.8
PXHV 140   P10R 10.1  MRHV -380
SIGNAL STATUS
LLAS   145 LSKY     0 GND      0
TEMPERATURE STATUS
TL     30 TE     18 TI     32 TB     20
HEATER OFF
BLOWER OFF
AUTOMATIC MODE
GAIN 0
LASER FREQUENCY 3
```

NOTE

All values shown are for sample purposes only. Values for version, serial number, and parameters may vary from unit to unit.

Figure 9.3.2. Sample Startup Message

Message format: <status data line 1>
<status data line 2>
<data table line 1>
<data table line 2>
!
!
<data table line 13>

Status Data Line 1 format:

NSB_$H_1H_1H_1H_1H_1$_$T_1T_1T_1T_1T_1$_$H_2H_2H_2H_2H_2$_$T_2T_2T_2T_2T_2$_$S_1S_2S_3S_4S_5S_6S_7S_8S_9S_{10}$

N =0 No significant backscatter (clear sky)
N =1 One layer detected
N =2 Two layers detected
N =3 Sky is fully obscured but no cloud base can be detected from echo signal received (e.g., fog or precipitation)
N =4 Sky is partially obscured and no cloud base is detected

S = 0 No alarm status bits S1...S4 ON for more than 5 minutes
S = 1 At least one alarm status S1...S4 ON for more than 5 minutes

B =_ Space if S = 0

B = 'bel' character if S = 1. Because 'bel' is a nonprinting character, the alarming line appears one character shorter in a printout than normally.

N = 0 or 4: $H_1=H_2=T_1=T_2$ = ///// (not defined)

N = 1 or 2: $H_1H_1H_1H_1H1$= Lowest detected cloud height in 5 digits. Leading zeros not suppressed.

$T_1T_1T_1T_1T_1$ = Range of backscatter of first layer; ///// if not defined

N = 2: $H_2H_2H_2H_2H_2$ = Second cloud height; ///// if not defined

$T_2T_2T_2T_2T_2$ = Range of backscatter of second layer; ///// if not defined

N = 3: $H_1H_1H_1H_1H_1$ = Calculated vertical visibility

$T_1T_1T_1T_1T_1$ = Signal range (i.e., height of highest detected backscatter)

STATUS INDICATORS:

S_1 = 1: Hardware alarm
S_2 = 1: Supply Voltage alarm
S_3 = 1: Laser power low
S_4 = 1: Temperature alarm
S_5 = 1: Solar shutter On
S_6 = 1: Blower On
S_7 = 1: Heater On
S_8 = 0: Unit is feet
1: Unit is meters
S_9 = 1: Not used (permanently set to 1)
S_{10} = 1: Polling Mode on

Figure 9.3.3. Digital Message No. 2 (Sheet 1 of 2)

Status Data Line 2 format:

G_F_N.NN_SUM_IIN_LAS_TL.x_OF.FS_XX_PP

G = 0 Gain used is 250
G = 2 Gain used is 930
F = 0 Laser pulse frequency used is 620 Hz (minimum)
F = 7 Laser pulse frequency is 1120 Hz (maximum)

N.NN = Noise RMS voltage is units of ADC increments, computed from the latest 12 s measurement period. One digit, two decimals.

SUM = Sum of total backscattered power per unit solid angle (i.e., range and instrument normalization applied). Three digits, no decimals. Leading zeros replaced by space characters.

IIN = Algorithm related internal processing information. Three digits.

LAS = Measured Laser Power in units of ADC increments (LLAS). Three digits.

TL.x = Internal variable indicating transmitter temperature. Two digits, one decimal; preceded by minus sign if negative. Degrees Celsius.

OF.FS = Offset of zero signal relative to Data Table minimum (=0), in units of ADC increments. Two digits, two decimals.

XX = Algorithm related internal processing information. Two digits.

PP = A 2-digit number representing calculated extinction coefficient values of 10 lowest range gates (0...500 ft). This 2-digit number determines if the obscuration is ground based.

Data Table Line format:

$HHD_0D_1D_2D_3$ .....D_{19}

Data scaled to hexadecimal number 0...FE (decimal 0...254). Overflow indicated by FF. Leading zero replaced by space character.

Data values are presented for each 50 ft range gate.

Height of first value in line in thousands of feet. Two digits; leading zero replaced by space. Twenty 50 ft values per line starting with 0 ft, next line 1000 ft. 13 lines altogether. Last line (12,000 ft) has 10 values.

Sample Message:

10_04200_00150_/////_/////_0000011010 (Status Data Line 1)

2_3_0.08_36_12_168_23.9_4.56_20_10 (Status Data Line 2)

_0DD.....DD (Data Table Line 1)
_1
_2
_3
_4
_5
_6 (DATA VALUES)
_7
_8
_9
10
11
12DD.....DD (Data Table Line 13)

Figure 9.3.3. Digital Message No. 2 (Sheet 2)

Message format: <status data line 1>
<backscatter data line>

Status Data Line 1 format:

NSB_$H_1H_1H_1H_1H_1$_$T_1T_1T_1T_1T_1$_$H_2H_2H_2H_2H_2$_$T_2T_2T_2T_2T_2$_$S_1S_2S_3S_4S_5S_6S_7S_8S_9S_{10}$

N = 0 No significant backscatter (clear sky)
N = 1 One layer detected
N = 2 Two layers detected
N = 3 Sky is fully obscured but no cloud base can be detected from echo signal received (e.g., fog or precipitation)
N = 4 Sky is partially obscured and no cloud base is detected

S = 0 No alarm status bits S1...S4 ON for more than 5 minutes
S = 1 At least one alarm status S1...S4 ON for more than 5 minutes

B = _ Space if S = 0

B = 'bel' character if S = 1. Because 'bel' is a nonprinting character, the alarming line appears one character shorter in a printout than normally.

N = 0 or 4: $H_1=H_2=T_1=T_2$ = ///// (not defined)

N = 1 or 2: $H_1H_1H_1H_1H_1$ = The lowest detected cloud height in 5 digits. Leading zeros not suppressed.

$T_1T_1T_1T_1T_1$ = Range of backscatter of first layer; ///// if not defined

N = 2: $H_2H_2H_2H_2H_2$ = Second cloud height; ///// if not defined

$T_2T_2T_2T_2T_2$ = Range of backscatter of second layer; ///// if not defined

N = 3: $H_1H_1H_1H_1H_1$ = Calculated vertical visibility

$T_1T_1T_1T_1T_1$ = Signal range (i.e., height of highest detected backscatter)

STATUS INDICATORS:

S_1 = 1: Hardware alarm
S_2 = 1: Supply Voltage alarm
S_3 = 1: Laser power low
S_4 = 1: Temperature alarm
S_5 = 1: Solar shutter On
S_6 = 1: Blower On
S_7 = 1: Heater On
S_8 = 0: Unit is feet
1: Unit is meters
S_9 = 1: Not used (permanently set to 1)
S_{10} = 1: Polling Mode on

Figure 9.3.4. Digital Message No. 3 (Sheet 1 of 2)

Backscatter Data Line format:

$D_1D_2D_3D_4.....D_{64}$

D_n Where n=1 to 64 is single ASCII-coded hexadecimal character 0...F where each bit of the 4-bit nibble of the hex character expressed in binary form represents one range gate.

With EMOD ON, range gate bit is 1 if ceilometer determined extinction coefficient at that range gate exceeds a value corresponding to a horizontal visibility of approximately 10 km (6 miles) except for three lowest range gates which have higher thresholds.

D_1 represents the four lowest 50 ft range gates (i.e., 0 ft, 50 ft, 100 ft, 150 ft), D_2 represents the four next 50 ft range gates (i.e., 200 ft, 250 ft, 300 ft, 350 ft), etc.

For example:

0 (0000) indicates no detectable backscatter in four adjacent range gates.
F (1111) indicates backscatter in all four range gates.
8 (1000) indicates backscatter in the lowest range gate only.
1 (0001) indicates backscatter in the highest range gate only.

All other characters indicate a gate-by-gate combination of backscatter according to the binary nibble, converted to hexadecimal.

Sample Message:

10_04200_00150_/////_/////_0000011010 (Status Data Line 1)
0001FFF80000000000007A000.. ..000 (Backscatter Data Line)

Figure 9.3.4. Digital Message No. 3 (Sheet 2)

9.3.6 CEILOMETER DIRECT DIALOGUE COMMANDS

9.3.6.1 **Introduction**. The maintenance procedures for the ceilometer rely heavily on the sensor's diagnostic capability. The maintenance technician is provided with the capability to communicate directly with the ceilometer's microprocessor to issue commands and receive messages. This function is referred to as direct dialogue mode. Direct dialogue mode can be invoked from the operator interface device (OID) ceilometer page using the DIALG key select. From this point, the technician can issue commands (ENTER COMMAND area) and receive (Direct Dialogue Message Received) messages using the OID. Technicians should be patient when operating in dialogue mode from an OID. The processing of some commands may take up to 90 seconds. Chapter 1 provides additional information on using direct dialogue mode from the OID. The technician uses direct dialogue mode to control and monitor the ceilometer locally.

9.3.6.2 **Line Open and Line Closed**. A single serial data interface is used for both ceilometer measurement data reports and maintenance communications with the sensor. To distinguish between these two uses, the interface has two states:

LINE CLOSED - Normal operation state. This is the default state upon power up. Measurement data messages are transmitted automatically when sensor is in Automatic Mode (paragraph 9.3.6.3). All commands other than SEND <CR> and OPEN <CR> (to OPEN the line) are ignored.

LINE OPEN - Direct dialogue mode. Ceilometer accepts and executes all commands entered at the > prompt.

The following examples show the command syntaxes and ceilometer responses for opening and closing the line:

Line Opened for Direct Dialogue	Line Closed for Normal Operation
`<ENTER>`	`>CLOS`
`LINE OPENED FOR OPERATOR COMMANDS`	`LINE CLOSED`
	`(measurement data messages resume)`
`>(ready for input)`	

NOTE

In Automatic Mode (paragraph 9.3.6.3), the line automatically closes if no entries are made within 1 minute.

Line may be opened in the middle of a message; however, the > prompt does not appear until the current message display is completed.

9.3.6.3 **Automatic Mode and Maintenance Mode**. There are two basic operating modes to the ceilometer:

Automatic Mode - There are two options under Automatic Mode:

Polling Mode Off (PMOD OFF): A measurement cycle and data message report is output at specified intervals. Internal monitoring and controls are updated every 15 seconds. The digital data messages are not displayed if the line is opened for direct dialogue.

Polling Mode On (PMOD ON): This is the normal operating mode for the ASOS ceilometer. The measurement cycles and internal monitoring function normally. Data outputs only occur when a SEND command is received by the sensor (from the DCP).

Maintenance Mode - Used for checking sensor operation. Measurement cycles are halted. Internal settings and controls may be operated and checked using specific commands.

The following examples show the command syntaxes and ceilometer responses for invoking the ceilometer operating mode:

To Invoke Maintenance Mode	To Invoke Automatic Mode
>AUTO OFF	>AUTO ON
WAIT FOR SEQUENCE STOP	AUTOMATIC MODE
MAINTENANCE MODE	>(ready for next input)
>(ready for next input)	

NOTE

The current measurement cycle is completed before switching to Maintenance Mode. The mode selected remains in effect over a sensor power down or restart.

9.3.6.4 **Command Descriptions**. The following paragraphs describe each of the commands available to the maintenance technician for use in direct dialogue with the ceilometer. Each command is briefly described, although only a few are of practical use to the maintenance technician due to the ASOS configuration. The use of these commands for troubleshooting and maintenance purposes is provided specifically in the maintenance section of this chapter.

9.3.6.4.1 **AUTO (ON/OFF)**. This command is used to define the operating mode of the ceilometer. Automatic mode is the normal operating mode and is automatically selected by the ASOS system software during normal operation. The maintenance technician can also select this mode by entering AUTO ON. As previously described (paragraph 9.3.6.3), the polling mode option can be either on or off while the sensor is in automatic mode. For the ceilometer to operate with ASOS, the polling mode option must be set to on using the PMOD command (paragraph 9.3.6.4.2). AUTO OFF is used to select the maintenance mode of operation for the ceilometer. This mode allows the technician to perform sensor checks and operations manually. During maintenance mode, the normal measurement cycle is halted and no measurement reports are generated. The maintenance mode also doubles as the standby mode so that the ceilometer halts operations until further commands are entered.

9.3.6.4.2 **PMOD (ON/OFF**). This command allows the technician to turn polled mode on and off. The polled mode option is a subset of Automatic Mode (paragraph 9.3.6.3). For ASOS operation, polled mode must be set to on. In this case, the ceilometer outputs data only in response to SEND command requests (polls) from the DCP. When polled mode is turned off, the ceilometer automatically outputs data at regular intervals.

9.3.6.4.3 **STA**. This command allows the technician to request a status report from the ceilometer and is used to obtain more detailed information from the ceilometer when an alarm is reported at the ceilometer OID display. The status data display reports the monitored voltage levels, signal and temperature levels, heater and blower status, operating mode, receiver gain, and laser pulse repetition frequency. An asterisk (*) immediately following any value on the status data display indicates an alarm value. A sample of the STA command display is shown on figure 9.3.5.

```
>STA
CT12K STATUS

00 ///// ///// ///// ///// 0000000010
POWER STATUS
P10D   8.5 P20I 21.5  M20I -20.7 P25V 27.9
M20A -20.9 P20A 19.3  P12M  13.1 P10X  9.9
PXHV 140   P10R 10.2  MRHV -382

SIGNAL STATUS
LLAS  155   LSKY  1     GND    0
TEMPERATURE STATUS
TL    30    TE    20    TI    34    TB    22
HEATER OFF
BLOWER OFF
AUTOMATIC MODE
GAIN 2
LASER FREQUENCY 3
>(next input)
```

NOTE
All values shown are for sample purposes only.

Figure 9.3.5. Status (STA) Command Display

9.3.6.4.4 **ALIM**. This command allows the technician to request the alarm limit message. Alarms are generated by comparing measured values against the alarm limit values. Voltage levels produce alarms when the measured voltage is below the alarm limit voltage value. Temperatures (in degrees Celsius) produce alarms when the measured value exceeds the limit value. The laser power level is in units of the analog-to-digital (A/D) converter circuit and produces an alarm when the measured value is less than the limit value. The sky light power level is of no practical significance and is allowed to be the full range of 0 through 255. The electrical ground reference is measured for self-test purposes and produces an alarm if the measured value exceeds the alarm limit value. The alarm limit values for all of the displayed values can be temporarily changed using the ALIM command. ALIM is entered, followed by the alarm limit to change, followed by the new value. For example, to change the external temperature alarm value to 105 degrees, the following command is entered: ALIM TE 105. Alarm limits that are changed in this manner are temporary; they are not retained by the system. Limits are returned to the default values by resetting the ceilometer or cycling power to the ceilometer. An example of the ALIM command display is shown on figure 9.3.6.

```
>ALIM
ALARM LIMITS
POWER LIMITS

P20I  15.0  P10X  7.5   M20A  15.0  P10R   7.0
MRHV  -150  P12M  8.0   P10D   6.0  P25V  20.0

PXHV  52    P20A 15.0   M20I -15.0
SIGNAL LIMITS

LLAS  155   LSKY  255   GND      4
TEMPERATURE LIMITS
TI    100 TE      100   TL      70  TB    80

>ALIM PXHV  54
NEW LIMIT         54.0

>(ready for input)
```

NOTE
All values shown are for sample purposes only.

Figure 9.3.6. Alarm Limits (ALIM) Command Display

9.3.6.4.5 **LASE (ON/OFF)**. This command controls the laser enable signal to the laser transmitter. This command is only possible in maintenance mode. LASE OFF disables the laser trigger enable signal, which prevents the ceilometer from transmitting. LASE ON enables the laser trigger signal to be generated; however, the SEQ command is also required to provide the timing sequence signals for a transmission. The command is automatically cleared after each measurement cycle. An example of the LASE command display is shown on figure 9.3.7.

```
>LASE ON
LASER IS ENABLED

>(ready for input)
```

Figure 9.3.7. Laser Control (LASE) Command Display

9.3.6.4.6 **SEQ (ON/OFF**). The SEQ command controls the timing sequence generator circuit of the ceilometer. This command is only possible in maintenance mode. SEQ OFF disables the sequence generator and thereby halts the transmit and receive cycles. SEQ ON enables the sequence generator to produce the required timing signals; however, transmission cycles also require the LASE command to output laser pulses. The command is automatically cleared after each measurement cycle. An example use of the SEQ command display is shown on figure 9.3.8.

```
>SEQ ON
SEQ ON

>(ready for input)
```

Figure 9.3.8. Sequence Control (SEQ) Command Display

9.3.6.4.7 **FREQ**. This command is used to check and specify the pulse repetition frequency for the laser pulse transmissions. The command may only be used in maintenance mode. The frequency is selected by

entering a number (from 0 to 7) after the FREQ command. Entering the command alone allows the current frequency to be displayed. An example of the FREQ command display is shown on figure 9.3.9.

```
>FREQ
LASER FREQ COUNT 2
>FREQ 5
LASER FREQ COUNT 5
>(next input)
```

NOTE

The allowable values for selecting the ceilometer nominal frequencies are:

Number	Frequency (in Hz)
0	620
1	660
2	710
3	770
4	830
5	910
6	1000
7	1120

Figure 9.3.9. Frequency Control (FREQ) Command Display

9.3.6.4.8 **GAIN (0/2)**. This command specifies the gain of the receiver measurement amplifier. GAIN 0 specifies a gain of 250; GAIN 2 specifies a gain of 930. When the GAIN command alone is entered, the present gain (0 or 2) is returned. This command is only available in maintenance mode. An example of the GAIN command display is shown on figure 9.3.10.

```
>GAIN
GAIN SELECT
0
>GAIN 2
GAIN SELECT
2
>(ready for input)
```

Figure 9.3.10. Receiver Gain Control (GAIN) Command Display

9.3.6.4.9 **HEAT (ON/OFF**). This command allows the technician to interrogate and control the operation of the window conditioner heater. When the HEAT command alone is entered, the present status (heater on or heater off) of the window conditioner is returned. The HEAT OFF command forces the heater off; HEAT ON forces the heater on. The HEAT ON command, however, only functions if the window conditioner blower is on. An example of the HEAT command display is shown on figure 9.3.11.

```
>HEAT
HEATER OFF

>HEAT ON
HEATER ON

>(ready for input)
```

Figure 9.3.11. Heater Control (HEAT) Command Display

9.3.6.4.10 **BLOW (ON/OFF)**. This command allows the technician to interrogate and control the operation of the window conditioner blower. When the BLOW command alone is entered, the present status (blower on or blower off) of the window conditioner is returned. The BLOW OFF command forces the blower unit off; BLOW ON forces the blower on. The BLOW OFF command also disables the window conditioner heater to protect the sensor from overheating. An example of the BLOW command display is shown on figure 9.3.12.

```
>BLOW
BLOWER OFF

>BLOW ON
BLOWER ON

>(ready for input)
```

Figure 9.3.12. Blower Control (BLOW) Command Display

9.3.6.4.11 **SHUT (ON/OFF)**. This command is used to interrogate and control the optional solar shutter of the ceilometer. When the SHUT command alone is entered, the present status (shutter on or shutter off) of the solar shutter is returned. The SHUT OFF command forces the solar shutter open; SHUT ON forces the shutter closed. If the ceilometer is not equipped with the optional solar shutter, the message NO SHUTTER is returned. An example of the SHUT command display is shown on figure 9.3.13.

```
>SHUT
SHUTTER IS OFF
>SHUT ON
SHUTTER IS ON

>(ready for input)
```

NOTE

In Automatic Mode, the command is canceled within 15 seconds due to the automatic operation sequence.

The SHUT OFF cannot cancel an ON state controlled by Light Monitor Board A5.

If ceilometer is not equipped with optional solar shutter, message NO SHUTTER is returned.

Figure 9.3.13. Solar Shutter Control (SHUT) Command Display

9.3.6.4.12 **TIME (HH MM SS)**. This command is used to interrogate and set the ceilometer's internal clock. The time is entered in the following format: HH MM SS

where: HH = Hours (0 to 23)
MM = Minutes (0 to 59)
SS = Seconds (0 to 59)

Spaces are used to separate the number groups, and the seconds group can be omitted. The time counting starts from zero following a system reset or cycling of power. The clock does not need to be set for the ceilometer to operate properly.

9.3.6.4.13 **DATE (YYYY MM DD)**. This command is used to interrogate and set the ceilometer's internal calendar. The date is entered in the following format: YYYY MM DD

where: YYYY = Year (four digits, such as 1990)
MM = Month (1 to 12)
DD = Day (1 to 31)

Spaces are used to separate the number groups. The system automatically accounts for leap years. The date starts from zero following a system reset or cycling of power. The calendar does not need to be set for the ceilometer to operate properly.

9.3.6.4.14 **RESE**. This command allows the technician to reset the ceilometer. The command halts all operations of the ceilometer and in approximately 5 seconds, initializes the ceilometer to the startup sequence.

9.3.6.4.15 **CAL (time**). This command is used to perform offset calibration for the ceilometer. The offset calibration is required following the replacement of any parts of the ceilometer. The time field specified is in seconds, with values from 120 to 240 recommended. The ceilometer performs an automatic calibration sequence for the time interval, stores the values in electrically erasable programmable read-only memory (EEPROM), and displays the values. Instructions for using this command are provided in Section V.

9.3.6.4.16 **HELP**. This command results in a display of the ceilometer command set. The commands TAB, GRAP, CAL, SERN, and SEND are not listed. Each command is followed by a brief description of its function. An example of the HELP command display is shown on figure 9.3.14.

```
>HELP
VAISALA CT 12K VERSION 2.46 SN: 87023

TIME       (HH MM(SS))
DATE       (YYYY MM DD)
MES        AUTOMATIC DATA MESSAGE
PAR        DISPLAY PARAMETERS
STA        STATUS MESSAGE
CONF       SYSTEM CONFIGURATION
CLIM       <LIMIT> CLOUD LIMIT
SLIM       <LIMIT> SIGNAL LIMIT
DEV        SET/DISPLAY DEVICE SCALE
TOTAL      <SIGNAL SUM> SET /DISPLAY THE NORMALIZED SIGNAL SUM LIMIT
NSCA       SET/DISPLAY NOISE SCALE
SCAL       SET/DISPLAY OUTPUT SCALE
LNOR       SET/DISPLAY THE LASER POWER NORM
PMOD       ON/OFF POLLING MODE
AUTO       ON/OFF AUTOMATIC MODE
BAUD       <RATE> SET/DISPLAY BAUD RATE (300, 1200, OR 2400)
RESET
LASE       ON/OFF LASER ENABLE DISABLE
SEQ        ON/OFF SEQUENCE START STOP
MEAS       <TIME S> LASER MEASUREMENT
HOFF       <HEIGHT> SET/DISPLAY OFFSET VALUE FOR THE MEASURED HEIGHTS
FREQ       0...7 SET/DISPLAY LASER PULSE FREQUENCY
NOIS       SAMPLE NOISE DISPLAY
AN         0...17 ANALOG TEST
GAIN       SELECT GAIN 0/2
HEAT       ON/OFF BLOWER HEATER CONTROL
BLOW       ON/OFF BLOWER CONTROL
SHUT       ON/OFF SOLAR SHUTTER MANUAL CONTROL
ALIM       <ID><VALUE> SET/DISPLAY ALARM LIMITS
RECT       RECORDER TEST OUTPUT UNTIL ESC
```

NOTE

Software version and serial number display may vary from those shown.

Figure 9.3.14. Help Message (HELP) Command Display

9.3.6.4.17 **MEAS (time)**. This command is used to manually force the ceilometer to take measurement samplings for the time specified. This command is only available in maintenance mode. The time field is specified in seconds, with 1 second the default value if none is specified. Upon completion of the measurement sequence, the raw range gate data values are available in table 0 of the ceilometer. The TAB command can be referenced for information on this table. An example of the MEAS command display is shown on figure 9.3.15.

```
>MEAS 12
BACK SCATTERED POWER
(12 sec. terminal inactivity)
INPUT DATA AV        15.9488

>(ready for input)
```

NOTE
Values shown are for example purposes only.

Figure 9.3.15. Measurement (MEAS) Command Display

9.3.6.4.18 **TAB n (si ci)**. This command displays the contents of the ceilometer internal data tables. The value specified in the field n selects the data table as follows:

n	Data table
0	Raw data in flash A/D converters
1	Intermediate calculation table
2	Final range and instrument normalized data values
3	Static offset data table
4	Instrument-only normalized data table

The si entry specifies the starting index (range from 0 to 253) that corresponds to the 50-foot range gate number from which output data start. Zero is the default value if none is specified. The ci entry specifies the cycling index (1 to 254) that corresponds to the number of range gates selected for continuous cyclic output. If not specified, the output is once. When specified, the output cycles continuously until aborted by the ESC key. The output of the table starts with the latest cloud heights and penetration in the form in Digital Message Status Line 1. Non-cloud obstruction heights are not indicated. Output lines contain the height of the first sample in the line, followed by five samples. An example of the TAB command display is shown on figure 9.3.16.

```
>TAB 3 17 13
LASER PULSE COUNT    10907
///// ///// ///// /////
850 16.0043 16.0010 15.9978 15.9945 15.9913
1100 15.9880 15.9848 15.9815 15.9783 15.9750
1350 15.9745 15.9740 15.9735

///// ///// ///// /////
850 16.0043 16.0010 15.9978 15.9945 15.9913
1100 15.9880 15.9848 15.9815 15.9783 15.9750
1350 15.9745 15.9740 15.9735

///// ///// ///// /////
850 16.0043 16.0010 15.9978 15.9945 15.9913

<ESC>
>(ready for input)
```

NOTE
All values shown are for sample purposes only.

Figure 9.3.16. Data Tables (TAB) Command Display

9.3.6.4.19 **GRAP n (sc si ic**). This command produces a semigraphic output of the internal measurement data. The n field specifies the data table to be graphed (refer to TAB command). The sc field is the scaling factor that specifies how many horizontal character positions equal the value 1.0000 in the table. If none is specified, 200 is the default value. The si field is the start index, which is the same as for si for the TAB command. If si is not specified, 10 (500 feet) is the default value. The ic field is the index counter (from 0 to 254) that specifies how many range gates (50-foot increments) are displayed. If not specified, the output is to end of range. Output is only once, with no cycling available. Output may be aborted using the ESC key. The display of range gate data is output one gate per line, starting from the start index. Each line contains the height points, one per character position, and an asterisk (*) as a mark for the data value of that range gate. An example of the GRAP command display is shown on figure 9.3.17.

```
>GRAP 0 100 0 12
  0 .......*
 50 *
100 ..............*
150 *
200 ....*
250 .......*
300 ..............*
350 ..............*
400 ....*
450 ....*
500 .......*
550 .........*

>(ready for input)
```

NOTE
All values shown are for sample purposes only.

Figure 9.3.17. Graphic Output (GRAP) Command Display

9.3.6.4.20 **MES**. This command outputs the data message from the ceilometer. In automatic mode, the message is that of the last completed measurement. In maintenance mode, a correctly formatted message is output, but only internal monitoring data are updated. The MEAS command is required to update the measurement data.

9.3.6.4.21 **PAR**. This command allows the technician to view the ceilometer system parameters. The resulting display shows each of the parameters, followed by its command and value. An example of the PAR command display is shown on figure 9.3.18. The value of any parameter is changed by entering the corresponding parameter command and the selected value or state. These parameters become stored in nonvolatile memory in the ceilometer and become the default values used by the system following a reset or cycling of power. Descriptions and examples for each parameter are provided in table 9.3.4.

```
>PAR
SYSTEM PARAMETERS
CLOUD LIMIT     CLIM       0.1000
SIGNAL LIMIT    SLIM       0.2000
DEVICE SCALE    DEV        1.2400
NOISE SCALE     NSCA       4.5000
OUTPUT SCALE    SCAL       100.0000
LASER NORM      LNOR       164
TOTAL SIGNAL    TOTAL      10.0000

HEIGHT OFFSET   HOFF       0
DATA UNIT FT

POLLED MESSAGES, PMOD ON
```

NOTE
Standard values are shown for example purposes; actual values may vary.

Figure 9.3.18. Parameter (PAR) Command Display

Table 9.3.4. Ceilometer Parameters

Parameter	Definition	Description
CLIM	Cloud limit	Sets the minimum increase in calculated extinction coefficient in ceilometer specific units that must be present over a short range for cloud base condition.
	EXAMPLE:	>CLIM CLOUD LIMIT CLIM 0.1600 >CLIM .1 CLOUD LIMIT CLIM 0.1000
SLIM	Signal limit	Sets the minimum in calculated extinction coefficient value in ceilometer specific units that must be present in one range gate for cloud base condition.
	EXAMPLE:	>SLIM SIGNAL LIMIT SLIM 0.2600 >SLIM .25 SIGNAL LIMIT SLIM 0.2500

Table 9.3.4. Ceilometer Parameters -CONT

Parameter	Definition	Description
DEV	Device scale	Multiplying scaling factor applied to all range gate values after normalization and prior to application of cloud detection algorithms and output. EXAMPLE: >DEV DEVICE SCALE DEV 1.20000 >DEV 1 DEVICE SCALE DEV 1.0000
NSCA	Noise scale	Multiplying scaling factor which, when multiplied with the RMS noise calculated from the 12-second measurement scan, sets the limit for discriminating between true signal and noise. Decreasing NSCA increases sensitivity but causes more noise hits. EXAMPLE: >NSCA NOISE SCALE NSCA 2.5000 >NSCA 3 NOISE SCALE NSCA 3.0000
SCAL	Scale	Multiplying scaling factor used to scale the value of PP. EXAMPLE: >SCAL OUTPUT SCALE SCAL 20.0000 >SCAL 10 OUTPUT SCALE SCAL 10.000
LNOR	Laser normal power level	Device specific parameter for 100% nominal laser power, in units of monitor A/D converter. Measured laser power (LLAS) is compared with this value for laser power control and measurement normalization. EXAMPLE: >LNOR LASER NORM LNOR 162 >LNOR 164 LASER NORM LNOR 164
TOTA	Total signal sum limit	Limit for determining full, partial, or no obscuration. For every 12-second scan, all range and equipment normalized range gate backscatter values are added to provide current signal sum (SUM). If SUM exceeds TOTA, full obscuration is concluded. If SUM is less than TOTA but greater than 0.4 x TOTA (40% of TOTA), partial obscuration is concluded. If SUM is less than 0.4 x TOTA, no significant obscuration is detected. EXAMPLE: >TOTA TOTAL SIGNAL LIMIT 6.00 CURRENT SIGNAL SUM 25.63 >TOTA 5 TOTAL SIGNAL LIMIT 5.00 CURRENT SIGNAL SUM 25.63

Table 9.3.4. Ceilometer Parameters -CONT

Parameter	Definition	Description
HOFF	Height Offset	Parameter for offsetting heights reported when ceilometer is installed considerably higher (positive value) or lower (negative value) than the desired level of interest (i.e., ceilometer is mounted on a rooftop, and the reports are to be in feet above runway ground level). The HOFF value must be in the same units as the data output (either feet or meters). EXAMPLE: >HOFF HEIGHT OFFSET HOFF 0
CONF	Configuration	Determines if the output is in feet (F) or meters (M) and indicates whether a solar shutter is installed (Y) or not (N). This command is interactive; i.e., the operator is prompted with questions. EXAMPLE: >CONF SELECT UNIT M/F ?F SHUTTER OPTION Y/N ?N END OF CONFIGURATION
SEND	Send message	Selects the digital signal message data output format (refer to paragraphs 9.3.5.2 and 9.3.5.3). EXAMPLE: >SEND AUTOMATIC MESSAGE: 3 >SEND 2 AUTOMATIC MESSAGE: 2 >SEND 2 AUTOMATIC MESSAGE: 2
AUTO	Automatic mode	Sets the ceilometer operating mode to automatic or maintenance mode (refer to paragraph 9.3.6.3). EXAMPLE: >AUTO MAINTENANCE MODE >AUTO ON AUTOMATIC MODE
PMOD	Polled mode	Sets the polled mode (subset of automatic mode) to on or off (refer to paragraph 9.3.6.3). For ASOS operator, polled mode should be ON. EXAMPLE: >PMOD ON POLLED MESSAGES, PMOD ON >PMOD OFF AUTOMATIC MESSAGES, PMOD OFF
SERN	Serial No.	Arbitrary serial number option. Only numbers from 0 to 999999 are allowed. Has no effect on operation. EXAMPLE: >SERN VAISALA CT 12K VERSION 2.44 SN:0 >SERN 87023 NEW VAISALA CT 12K VERSION 2.44 SN:87023

9.3.6.4.22 **AN (Channel)**. This command provides a continuous display output of analog monitored signals. The value displayed is the A/D converter output and is in the range of 0 to 255. Output is aborted using the ESC key. If no channel number is specified, the A/D converter internal self-test channel is displayed (normal value is 125 to 131). The channel number specifies which analog signal is monitored and displayed as follows:

Channel	Signal	Normal value
0	P20I	192 ±32
1	P20A	179 ±32
2	P25V	172 ±27
3	P10D	131 ±33
4	P10R	155 ±33
5	P10X	155 ±33
6	P12M	196 ±41
7	PXHV*	82 ±20
8	LLAS	77 to 230
9	LSKY	0 to 255
10	TE*	152 ±3
11	TB*	152 ±3
12	TI*	152 ±3
13	TL*	152 ±3
14	M20I	184 ±32
15	MRHV*	158 ±41
16	M20A	184 ±32
17	GND	0 to 1

* These voltages are temperature dependent and may vary from the given ranges depending on the installation temperature.

9.3.6.4.23 **NOIS**. This command provides a continuous output of the highest, average, and lowest receiver data measurement sample recorded after the final phase of the last completed scan. This gives the light noise levels detected by the receiver. The data displayed are in units of the A/D converter. Data updates are instantaneous in maintenance mode, and once every 12 seconds in automatic mode. The message output is terminated by the escape key <ESC>. An example of the NOIS command display is shown on figure 9.3.19.

```
>NOIS
NOISE MEASUREMENT
19    16    13
19    16    13
19    16    13
!
!
!
<ESC>
>(ready for input)
```

Figure 9.3.19. Noise (NOIS) Command Display